DECLARATION

I, Tatsuya Ina, a Patent Attorney, of Ogikubo TM Bldg. 2F, 5-26-13, Ogikubo, Suginami-ku, Tokyo 167-0051, Japan, solemnly and sincerely declare:

That I have a thorough knowledge of Japanese and English languages; and

That the attached pages contain a correct translation into English of the specification of the following Japanese Patent Application:

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Tatsuya Ina

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[Title of the Invention] SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURE THEREOF, CIRCUIT BOARD AND ELECTRONIC INSTRUMENT

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[Inventor]

[Address] C/O SEIKO EPSON CORPORATION
3-3-5, Owa, Suwa-shi, Nagano-ken

[Name] Nobuaki Hashimoto

[Applicant]

[Identification Number] 000002369

[Name] SEIKO EPSON CORPORATION

[Agent]

[Identification Number] 100090479

[Patent Attorney]

[Name] Hajime Inoue

[Telephone] 03-5397-0891

[Agent]

[Identification Number] 100090387

[Patent Attorney]

[Name] Yukio Fuse

[Telephone] 03-5397-0891

[Agent]
[Identification Number] 100090398
[Patent Attorney]
[Name] Michie Ofuchi
[Telephone] 03-5397-0891

[List of the Documents Attached]

[Document]	Specification	1 copy
[Document]	Drawings	1 copy
[Document]	Abstract	1 copy
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[Document Name] SPECIFICATION

[Title of the Invention] SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURE THEREOF, CIRCUIT BOARD AND ELECTRONIC INSTRUMENT

[Patent Claims]

[Claim 1] A method of manufacturing a semiconductor device having one surface on which a substrate wiring pattern is formed and the other surface on which electrodes of a semiconductor element are formed, said method comprising: a first step of interposing an anisotropic conductive material between said one surface on which a substrate wiring pattern is formed and said other surface on which electrodes of a semiconductor element are formed, said anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed and being larger than said surfaces of said semiconductor element; a second step of pressuring and heating said other surface on which electrodes of a semiconductor element are formed toward said substrate with said other surface being positioned opposed to said substrate, thereby providing an electrical connection between said wiring pattern and said electrodes through said conductive particles and setting said anisotropic conductive material in a region in which said anisotropic conductive material is in contact with said semiconductor element; and a third step of heating a region other than said region in which said anisotropic conductive material is in contact with said semiconductor element.

[Claim 2] The method of manufacturing a semiconductor device as defined in claim 1, wherein the region heated in said third step is a region in which a portion of said anisotropic

conductive material not set in said second step is positioned.

[Claim 3] The method of manufacturing a semiconductor device as defined in claim 1 or 2, wherein said third step includes a step of heating said anisotropic conductive material through a heating jig which is in contact with a region other than said region in which said anisotropic conductive material is in contact with said semiconductor element.

[Claim 4] The method of manufacturing a semiconductor device as defined in any one of claims 1 to 3, further comprising a reflow step performed when solder balls connected to said wiring pattern are formed on said substrate and wherein said third step is carried out in said reflow step.

[Claim 5] The method of manufacturing a semiconductor device as defined in any one of claims 1 to 3, further comprising another reflow step of electrically connecting electronic parts other than said semiconductor element to said wiring pattern and wherein said third step is carried out in said another reflow step.

[Claim 6] A method of manufacturing a semiconductor device having one surface on which a substrate wiring pattern is formed and the other surface on which electrodes of a semiconductor element are formed, said method comprising: a first step of interposing an anisotropic conductive material between said one surface on which a substrate wiring pattern is formed and said other surface on which electrodes of a semiconductor element are formed, said anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed and being larger than said surfaces of

said semiconductor element; a second step of pressuring and heating said other surface on which electrodes of a semiconductor element are formed toward said substrate with said other surface being positioned opposed to said substrate, thereby providing an electrical connection between said wiring pattern and said electrodes through said conductive particles and setting said anisotropic conductive material in a region in which said anisotropic conductive material is in contact with said semiconductor element; and a third step of cutting off said substrate in a region in which said anisotropic conductive material extends outwardly from said semiconductor element.

[Claim 7] The method of manufacturing a semiconductor device as defined in claim 6, wherein a position at which said anisotropic conductive material is cut off is in a region located outwardly from the end of said wiring pattern on said substrate.

[Claim 8] The method of manufacturing a semiconductor device as defined in claim 6 or 7, wherein the whole of said anisotropic conductive material is set in said second step and wherein said set anisotropic conductive material is cut off in said third step.

[Claim 9] A method of manufacturing a semiconductor device, comprising a first step of providing a substrate on which a wiring pattern is formed, said substrate being covered with a protection layer except a mounting portion of said substrate on which a semiconductor element is mounted and its surrounding portion; a second step of forming an anisotropic conductive material over said substrate in a region extending

between said mounting portion and said protection layer, said anisotropic conductive material including conductive particles dispersed in a thermosetting adhesive; and a third step of placing a portion of said semiconductor element having electrodes over said anisotropic conductive material to provide an electrical connection between said wiring pattern and said electrodes.

[Claim 10] The method of manufacturing a semiconductor device as defined in claim 9 wherein said wiring pattern is electrically connected to said electrodes through said anisotropic conductive material by pressurizing and heating said semiconductor element toward said substrate in said third step and wherein said anisotropic conductive material is formed to extend to at least a part of the side of said semiconductor element in said third step.

[Claim 11] The method of manufacturing a semiconductor device as defined in claim 10 wherein said anisotropic conductive material is formed in said second step so as to have its thickness larger than the spacing between said semiconductor element and said substrate after said third step and wherein said anisotropic conductive material is extended outwardly from said semiconductor element by pressurizing said anisotropic conductive material between said semiconductor element and said substrate in said third step.

[Claim 12] A method of manufacturing a semiconductor device, comprising a first step of providing an anisotropic conductive material on a surface of a substrate on which a wiring pattern is formed, said anisotropic conductive material

including a thermosetting adhesive in which conductive particles are dispersed, and placing a surface of said semiconductor element having electrodes over said anisotropic conductive material; and a second step of pressurizing and heating said semiconductor element toward said substrate to provide an electrical connection between said wiring pattern and said electrodes through said conductive particles, said anisotropic conductive material including a shading material.

[Claim 13] A semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern is formed; an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said anisotropic conductive material being to provide an electrical connection between said wiring pattern and said electrodes in a region between one surface of said substrate on which said wiring pattern is formed and another surface of said substrate on which said electrodes of said semiconductor element are formed, said anisotropic conductive material having a magnitude larger than that of said semiconductor element and being wholly set.

[Claim 14] A semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern to be electrically connected to said electrodes is formed; a protection layer provided on said substrate except a mounting portion of said substrate on which said semiconductor element is mounted and its surrounding portion; and an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said

anisotropic conductive material being located in a region between said mounting portion and said protection layer, said surface of said semiconductor element on which said electrodes are formed being in contact with said anisotropic conductive material to provide an electrical connection between said electrodes and said wiring pattern.

[Claim 15] A semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern is formed; an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said anisotropic conductive material being to provide an electrical connection between said wiring pattern and said electrodes in a region between one surface of said substrate on which said wiring pattern is formed and another surface of said substrate on which said electrodes of said semiconductor element are formed, said anisotropic conductive material covering at least a part of the side of said semiconductor element.

[Claim 16] A semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern is formed; an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said anisotropic conductive material being to provide an electrical connection between said wiring pattern and said electrodes in a region between one surface of said substrate on which said wiring pattern is formed and another surface of said substrate on which said electrodes of said semiconductor element are formed, said anisotropic

conductive material including a shading material.

[Claim 17] The semiconductor device as defined in any one of claims 13, 15 and 16 wherein said anisotropic conductive material covers the whole of said wiring pattern.

[Claim 18] A semiconductor device produced according to the method as defined in any one of claims 1 to 12.

[Claim 19] A circuit board on which the semiconductor device as defined in any one of claims 13 to 18 is mounted.

[Claim 20] An electronic instrument having the circuit board as defined in claim 19.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention belongs]

The present invention relates to a semiconductor device and method of manufacture thereof, and to a circuit board and an electronic instrument.

[0002]

[Background of the Invention]

In recent years, with the increasing compactness of electronic instruments, semiconductor device packages adapted to high density mounting are in demand. In response to this, surface mounting packages such as a ball grid array (BGA) and a chip scale/size package (CSP) have been developed. In a surface mounting package, a substrate may be used which has formed thereon a wiring pattern for connection to a semiconductor element.

[0003]

In a conventional surface mounting package, it has been

difficult to improve the reliability and productivity since the semiconductor element and wiring pattern are interconnected through an alloy such as solder or the like.

[0004]

The present invention solves this problem, and has as its objective the provision of a method of manufacturing a semiconductor device and a semiconductor device manufactured by said method, of a circuit board and of an electronic instrument, having excellent reliability and productivity.

[0005]

[Means for solving the Problem]

(1) The present invention provides a method of manufacturing a semiconductor device having one surface on which a substrate wiring pattern is formed and the other surface on which electrodes of a semiconductor element are formed, said method comprising: a first step of interposing an anisotropic conductive material between said one surface on which a substrate wiring pattern is formed and said other surface on which electrodes of a semiconductor element are formed, said anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed and being larger than said surfaces of said semiconductor element; a second step of pressuring and heating said other surface on which electrodes of a semiconductor element are formed toward said substrate with said other surface being positioned opposed to said substrate, thereby providing an electrical connection between said wiring pattern and said electrodes through said conductive particles and setting said anisotropic conductive

material in a region in which said anisotropic conductive material is in contact with said semiconductor element; and a third step of heating a region other than said region in which said anisotropic conductive material is in contact with said semiconductor element.

[0006]

According to the present invention, the semiconductor device can be produced in a manner improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0007]

In addition, the anisotropic conductive material is set by heating the anisotropic conductive material through the semiconductor element at a region in which it is in contact with the semiconductor element. Thereafter, the region of the anisotropic conductive material other than the contact region is thermally set. Thus, the portion of the anisotropic conductive material extending outwardly from the semiconductor element can also be set. As a result, the anisotropic conductive material can be prevented from being peeled off so that the moisture enters the semiconductor device to create the migration of the wiring pattern. Furthermore, the moisture can be removed by setting the anisotropic conductive material.

[0008]

(2) In the method of manufacturing a semiconductor device, the region heated in said third step may be a region in which a portion of said anisotropic conductive material not set in said second step is positioned.

[0009]

(3) In the method of manufacturing a semiconductor device, said third step may be carried out to heat said anisotropic conductive material through a heating jig which is in contact with a region other than said region in which said anisotropic conductive material is in contact with said semiconductor element.

[0010]

(4) In the method of manufacturing a semiconductor device, a reflow step may be performed when solder balls connected to said wiring pattern are formed on said substrate, said third step being carried out in said reflow step.

[0011]

(5) In the method of manufacturing a semiconductor device, another reflow step of electrically connecting electronic parts other than said semiconductor element to said wiring pattern may be performed, said third step being carried out in said another reflow step.

[0012]

The present invention also provides a method of manufacturing a semiconductor device having one surface on which a substrate wiring pattern is formed and the other surface on which electrodes of a semiconductor element are formed, said method comprising: a first step of interposing an anisotropic conductive material between said one surface on which a substrate wiring pattern is formed and said other surface on which electrodes of a semiconductor element are formed, said anisotropic conductive material including a thermosetting

adhesive in which conductive particles are dispersed and being larger than said surfaces of said semiconductor element; a second step of pressuring and heating said other surface on which electrodes of a semiconductor element are formed toward said substrate with said other surface being positioned opposed to said substrate, thereby providing an electrical connection between said wiring pattern and said electrodes through said conductive particles and setting said anisotropic conductive material in a region in which said anisotropic conductive material is in contact with said semiconductor element; and a third step of cutting off said substrate in a region in which said anisotropic conductive material extends outwardly from said semiconductor element.

[0013]

According to the present invention, the semiconductor device can be produced in a manner improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0014]

In addition, the anisotropic conductive material is not required to be positioned accurately for the magnitude of the semiconductor element since the anisotropic conductive material is cut off after it has been formed to extend outwardly from the semiconductor element. Since the outwardly extended portion of the anisotropic conductive material is cut off together with the substrate material, the entire surface of the substrate is covered with the anisotropic conductive material. This prevents the migration of the wiring pattern and so on.

[0015]

(7) In the method of manufacturing a semiconductor device, a position at which said anisotropic conductive material may be cut off is in a region located outwardly from the end of said wiring pattern on said substrate.

[0016]

(8) In the method of manufacturing a semiconductor device, the whole of said anisotropic conductive material may be set in said second step and said set anisotropic conductive material may be cut off in said third step.

[0017]

Thus, the set anisotropic conductive material can easily be cut off.

[0018]

(9) The present invention further provides a method of manufacturing a semiconductor device, comprising a first step of providing a substrate on which a wiring pattern is formed, said substrate being covered with a protection layer except a mounting portion of said substrate on which a semiconductor element is mounted and its surrounding portion; a second step of forming an anisotropic conductive material over said substrate in a region extending between said mounting portion and said protection layer, said anisotropic conductive material including conductive particles dispersed in a thermosetting adhesive; and a third step of placing a portion of said semiconductor element having electrodes over said anisotropic conductive material to provide an electrical connection between said wiring pattern and said electrodes.

[0019]

According to the present invention, the semiconductor device can be produced in a manner improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0020]

In addition, the anisotropic conductive material is provided to overlap the protection layer. Thus, there will be formed no gap between the anisotropic conductive material and the protection layer. Therefore, the wiring pattern will not be exposed to prevent the migration thereof.

[0021]

(10) In the method of manufacturing a semiconductor device, said wiring pattern may be electrically connected to said electrodes through said anisotropic conductive material by pressurizing and heating said semiconductor element toward said substrate in said third step. Said anisotropic conductive material may be formed to extend to at least a part of the side of said semiconductor element in said third step.

[0022]

According to the present invention, the semiconductor device can be produced in a manner improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0023]

In addition, the anisotropic conductive material is formed to extend to at least a part of the side of said semiconductor element. Thus, the electrodes cannot be brought

into contact with any penetrating moisture to prevent the corrosion, in addition to the protection of the semiconductor element from a mechanical break-down.

[0024]

(11) In the method of manufacturing a semiconductor device, said anisotropic conductive material may be formed in said second step so as to have its thickness larger than the spacing between said semiconductor element and said substrate after said third step. Said anisotropic conductive material may be extended outwardly from said semiconductor element by pressurizing said anisotropic conductive material between said semiconductor element and said substrate in said third step.

[0025]

(12) The present invention further provides a method of manufacturing a semiconductor device, comprising a first step of providing an anisotropic conductive material on a surface of a substrate on which a wiring pattern is formed, said anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, and placing a surface of said semiconductor element having electrodes over said anisotropic conductive material; and a second step of pressurizing and heating said semiconductor element toward said substrate to provide an electrical connection between said wiring pattern and said electrodes through said conductive particles. Said anisotropic conductive material includes a shading material.

[0026]

According to the present invention, the semiconductor

device can be produced in a manner improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0027]

In addition, since the anisotropic conductive material includes a shading material, any stray light to the surface of the semiconductor element having the electrodes can be blocked. Thus, any wrong operation in the semiconductor element can be avoided.

[0028]

(13) The present invention further provides a semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern is formed; an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said anisotropic conductive material being to provide an electrical connection between said wiring pattern and said electrodes in a region between one surface of said substrate on which said wiring pattern is formed and another surface of said substrate on which said electrodes of said semiconductor element are formed, said anisotropic conductive material having a magnitude larger than that of said semiconductor element and being wholly set.

[0029]

According to the present invention, the semiconductor device can be improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0030]

In addition, since the anisotropic conductive material is also set outside the region at which it is in contact with the semiconductor element, the anisotropic conductive material can be prevented from being peeled off so that the moisture enters the semiconductor device to create the migration of the wiring pattern. Furthermore, the moisture can be removed by setting the whole anisotropic conductive material.

[0031]

(14) The present invention further provides a semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern to be electrically connected to said electrodes is formed; a protection layer provided on said substrate except a mounting portion of said substrate on which said semiconductor element is mounted and its surrounding portion; and an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said anisotropic conductive material being located in a region between said mounting portion and said protection layer, said surface of said semiconductor element on which said electrodes are formed being in contact with said anisotropic conductive material to provide an electrical connection between said electrodes and said wiring pattern.

[0032]

According to the present invention, the semiconductor device can be improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes

through the anisotropic conductive material.

[0033]

In addition, the anisotropic conductive material is provided to overlap the protection layer. Thus, there will be formed no gap between the anisotropic conductive material and the protection layer. Therefore, the wiring pattern will not be exposed to prevent the migration thereof.

[0034]

(15) The present invention further provides a semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern is formed; an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said anisotropic conductive material being to provide an electrical connection between said wiring pattern and said electrodes in a region between one surface of said substrate on which said wiring pattern is formed and another surface of said substrate on which said electrodes of said semiconductor element are formed, said anisotropic conductive material covering at least a part of the side of said semiconductor element.

[0035]

According to the present invention, the semiconductor device can be improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0036]

In addition, the anisotropic conductive material can protect the semiconductor element from a mechanical break-down

since the anisotropic conductive material covers at least a part of the side of the semiconductor element. Since the semiconductor element is covered with the anisotropic conductive material at a position remote from the electrodes, the moisture hardly reaches the electrodes. This can prevent the corrosion in the electrodes.

[0037]

(16) The present invention further provides a semiconductor device comprising a semiconductor element having electrodes; a substrate on which a wiring pattern is formed; an anisotropic conductive material including a thermosetting adhesive in which conductive particles are dispersed, said anisotropic conductive material being to provide an electrical connection between said wiring pattern and said electrodes in a region between one surface of said substrate on which said wiring pattern is formed and another surface of said substrate on which said electrodes of said semiconductor element are formed, said anisotropic conductive material including a shading material.

[0038]

According to the present invention, the semiconductor device can be improved in reliability and productivity since the wiring pattern is electrically connected to the electrodes through the anisotropic conductive material.

[0039]

In addition, since the anisotropic conductive material includes a shading material, any stray light to the surface of the semiconductor element having the electrodes can be blocked.

Thus, any wrong operation in the semiconductor element can be avoided.

[0040]

(17) In the semiconductor device, said anisotropic conductive material may cover the whole of said wiring pattern.

[0041]

(18) The present invention provides a semiconductor device produced according to any of the aforementioned methods.

[0042]

(19) The present invention further provides a circuit board on which any one of the aforementioned semiconductor devices is mounted.

[0043]

(20) The present invention further provides an electronic instrument having any one of the aforementioned circuit boards.

[0044]

[Embodiments of the Invention]

Several preferred embodiments of the present invention will now be described with reference to the drawings.

[0045]

(First Embodiment)

Figs. 1(A)-(D) show a method of making a semiconductor device according to the first embodiment of the present invention. In this embodiment, a substrate 12 is used which has a wiring pattern 10 formed on at least one surface 18, as shown in Fig. 1(A).

[0046]

The substrate 12 may be a flexible substrate formed of an

organic material, a metal substrate formed of an inorganic material, or a combination of these. As a flexible substrate may be used a tape carrier. If the electric conductivity of the substrate 12 is high, an insulating film is formed between the substrate 12 and the wiring pattern 10 and on the inner walls of through-holes 14. In addition, the insulating film may also be formed on a surface of the substrate opposite to the surface on which the wiring pattern 10 is formed.

[0047]

The through-holes 14 are formed in the substrate 12, and the wiring pattern 10 is formed on the substrate, covering the through-holes 14. Lands 17 for external electrodes are formed over the through-holes 14, as part of the wiring pattern 10.

[0048]

An anisotropic conductive material 16 is provided on such a substrate12. The anisotropic conductive material 16 comprises an adhesive (binder) in which are dispersed conductive particles (conductive filler). In some cases, a dispersant may be added in the anisotropic conductive material 16. The anisotropic conductive material 16 could be previously formed as a sheet that is in turn affixed to the substrate 12, or it could equally well be provided as a liquid on the substrate 12. The anisotropic conductive material 16 is larger than a surface 24 of a semiconductor element 20 on which electrodes 22 are provided.

[0049]

In this embodiment, a thermosetting adhesive is used as the anisotropic conductive material, and the anisotropic conductive material 16 may further include a shading material. As a shading

material can be used, for example, a black dye or black pigment dispersed in an adhesive resin.

[0050]

Next, the semiconductor element 20 is placed on the anisotropic conductive material 16. More particularly, the semiconductor element 20 is placed on the anisotropic conductive material 16 such that the surface 24 of the semiconductor element 20 having the electrodes 22 faces the anisotropic conductive material 16. Moreover, the semiconductor element 20 is disposed so that each of the electrode 22 is positioned over a land (not shown) for connection of the electrodes to the wiring pattern 10. It should be noted that the semiconductor element 20 may have the electrodes 22 formed only on two edges, or may have the electrodes 22 formed on four edges. The electrodes 22 are frequently in the form of projections made of gold, solder or the like provided on aluminum pads. Alternatively, the electrodes 22 may be formed on the wiring pattern 10 in the form of such projections or projections formed by etching the wiring pattern 10.

[0051]

By means of the above process, the anisotropic conductive material 16 will be positioned between the surface 24 of the semiconductor element 20 having the electrodes 22 and the surface 18 of the substrate 12 on which the wiring pattern 10 is formed. A jig 30 is then used to press a surface 26 of the semiconductor element 20 opposite to the surface 24 having the electrodes 22 such that the semiconductor element 20 is subjected to pressure in the direction of the substrate 12. The jig 30 includes an internal heater 32 for heating the semiconductor element 20. It should be

noted that considering the requirement as far as possible to apply heat also to the spread out portion of the anisotropic conductive material 16, the jig 30 used preferably has a greater flat surface area than that of the semiconductor element 20. In this way, heat can easily be applied to the periphery of the semiconductor element 20.

[0052]

Thus, as shown in Fig. 1(B), the electrodes 22 of the semiconductor element 20 and the wiring pattern 10 are electrically interconnected through the conductive particles in the anisotropic conductive material 16. According to this embodiment, since the wiring pattern 10 and electrodes 22 are electrically interconnected through the anisotropic conductive material 16, a semiconductor device can be manufactured in a manner improved in reliability and productivity.

[0053]

Since heat is applied to the semiconductor element 20 by the jig 30, the adhesive of the anisotropic conductive material 16 is cured at the region in which it is in contact with the semiconductor element 20. In the region not contacting the semiconductor element 20 or the region spaced apart from the semiconductor element 20, heat does not reach the anisotropic conductive material 16, so that the curing is incomplete. The curing of these regions is carried out in the following step.

[0054]

As shown in Fig. 1(C), solder 34 is provided within and around the periphery of the through-holes 14 in the substrate 12(A) cream solder or the like may be used to form the solder 34 by printing.

Alternatively, pre-formed solder balls may be mounted in the above-described position.

[0055]

The solder 34 is then heated in a reflow step, and solder balls 36 are formed as shown in Fig. 1(D). The solder balls 36 function as external electrodes. In this reflow step, not only the solder 34 but also the anisotropic conductive material 16 is heated. This heat cures the regions of the anisotropic conductive material 16 which are not yet cured. That is to say, of the anisotropic conductive material 16, the region not contacting the semiconductor element 20 or the region spaced apart from the semiconductor element 20, is cured in the reflow step of forming the solder balls 36.

[0056]

In the thus obtained semiconductor device 1, since the whole of the anisotropic conductive material 16 is cured, the possibility of the anisotropic conductive material 16 around the semiconductor element 20 coming apart from the substrate 12 and allowing the ingress of water, leading to migration of the wiring pattern 10 is prevented. Since the whole of the anisotropic conductive material 16 is cured, the inclusion of water within the anisotropic conductive material 16 can also be prevented.

[0057]

Further in the semiconductor device 1, since the electrodes 22 provided on the surface 24 of the semiconductor element 20 are covered by the anisotropic conductive material 16 which includes a shading material, light can be prevented from reaching this surface 24. Therefore, malfunction of the semiconductor element 20 can be prevented.

[0058]

Figs. 2(A) and 2(B) show modifications of the first embodiment. In these modifications, the structure which is the same as in the first embodiment is indicated by the same reference numerals, and description of this structure and the effect of this structure are omitted. The same is true for the following.

[0059]

The step shown in Fig. 2(A) can be carried out after the step of Fig. 1(B) and before the step of Fig. 1(C). More particularly, of the anisotropic conductive material 16, the region not contacting the semiconductor element 20 and the region apart from the semiconductor element 20, are heated by a heating jig 38. The heating jig 38 is preferably provided with a surface treated with Teflon or the like so that the uncured anisotropic conductive material 16 hardly adheres to the heating jig 38.having high non-adhesive properties to the anisotropic conductive material 16 that is an example of an adhesive, so that the uncured anisotropic conductive material 16 does not adhere thereto. Thus, of the anisotropic conductive material 16, the region not contacting the semiconductor element 20 and the region apart from the semiconductor element 20 can be cured. In place of a jig, a hot air blower or optical heater capable of localized heating may be used.

[0060]

Alternatively, as shown in Fig. 2(B), after the step of Fig. 1(B) and before the step of Fig. 1(C), a reflow step may be carried out to electrically connect an electronic component 40 distinct from the semiconductor element 20 to the wiring pattern 10. By means

of this reflow step, of the anisotropic conductive material 16, the region not contacting the semiconductor element 20 and the region apart from the semiconductor element 20 is heated and cured. The electronic component 40 may include any of various parts such as resistor, capacitor, coil, oscillator, filter, temperature sensor, thermistor, varistor, variable resistor and fuse.

[0061]

Even according to these modifications, the whole of the anisotropic conductive material 16 can be cured, and the possibility of the anisotropic conductive material 16 coming apart from the substrate 12 and allowing the ingress of water, leading to migration of the wiring pattern 10 can be prevented. Since the whole of the anisotropic conductive material 16 is cured, the inclusion of water can also be prevented.

[0062]

Although this embodiment has been described with a substrate with a wiring pattern on one side only as the substrate 12, the present invention is not limited to such an arrangement, but may be applied to a double-sided wiring substrate or multi-layer wiring substrate. In this case, in stead of disposing solder in the through-holes, solder balls may be formed on lands provided on the surface opposite to that on which the semiconductor element is mounted. In place of solder balls other conductive projections may be used. The connection between the semiconductor element and the substrate may be carried out by wire bonding. These observations apply equally to the following.

[0063]

(Second Embodiment)

A method of manufacturing a semiconductor device in accordance with the second embodiment is shown in Fig. 3(A) and 3(B). This embodiment is carried out following on from the first embodiment.

[0064]

More specifically, in this embodiment, following on from the step of Fig. 1(D), the anisotropic conductive material 16 and substrate 12 are held by a fixed blade 41, and cut by a movable blade 42 to a size slightly larger than the semiconductor element 20, as shown in Fig. 3(A), yielding a semiconductor device 2 shown in Fig. 3(B). The cutting means is not limited thereto, and any other available cutting means and holding means can be applied. Since the semiconductor device 2 is cut together with the anisotropic conductive material 16, the cut through the two is coplanar, and the entire surface of the substrate 12 is covered with the anisotropic conductive material 16. Therefore, the wiring pattern 10 is not exposed, and moisture is prevented from reaching the wiring pattern 10 and causing migration.

[0065]

According to this embodiment, since the anisotropic conductive material 16 is cut, it is not required to be previously cut to the same size as the semiconductor element 20 or slightly larger, and accurate positioning with respect to the semiconductor element 20 is not required.

[0066]

It should be noted that this embodiment is an example of the anisotropic conductive material 16 and substrate 12 being cut after the solder balls 36 are formed, but the timing of the cut is

independent of the formation of the solder balls 36, as long as it is at least after the semiconductor element 20 has been mounted on the anisotropic conductive material 16. However, the anisotropic conductive material 16 is preferably cured at least in the region of contact with the semiconductor element 20. In this case, misalignment between the semiconductor element 20 and wiring pattern 10 can be prevented. If the anisotropic conductive material 16 is cured rather than uncured in the location of the cut, the cutting operation will be easier.

[0067]

(Third Embodiment)

A method of manufacturing a semiconductor device in accordance with one embodiment of the present invention is shown in Figs. 4(A) and 4(B). In this embodiment, the substrate 12 of the first embodiment is used, and on the substrate 12 is formed a protective layer 50. The protective layer 50 is such as to cover the wiring pattern 10, preventing contact with water, and for example solder resist may be used.

[0068]

The protective layer 50 is formed around a region 52 that is larger in extent than the region in which the semiconductor element 20 is mounted on the substrate 12. That is to say, the region 52 is larger than the surface 24 of the semiconductor element 20 having the electrodes 22. Within this region 52, the lands (not shown) for connection to the electrodes 22 of the semiconductor element 20 are formed on the wiring pattern 10.

[0069]

On such a substrate 12, an anisotropic conductive material

54 of a material which can be selected as the anisotropic conductive material 16 of the first embodiment is provided. It should be noted that the anisotropic conductive material 54 does not necessarily contain a shading material, but if it does contain a shading material then the same effect as in the first embodiment is obtained.

[0070]

In this embodiment, the anisotropic conductive material 54 is provided from the region of mounting of the semiconductor element 20 to the protective layer 50. That is to say, the anisotropic conductive material 54 covers the wiring pattern 10 and substrate 12 in the region 52 in which the protective layer 50 is not formed, and is also formed to overlap the edge of the protective layer 50 surrounding the region 52.

[0071]

The semiconductor element 20 is then pressed toward the substrate 12 and heat is applied by the jig 30, as shown in Fig. 4(A). In this way, the electrodes 22 of the semiconductor element 20 and the wiring pattern 10 are electrically interconnected, as shown in Fig. 4(B). Thereafter, in the same way as in the steps shown in Figs. 1(C) and 1(D), solder balls are formed, and the semiconductor device is obtained.

[0072]

According to this embodiment, the anisotropic conductive material 54 is not only formed in the region 52 in which the protective layer 50 is not formed, but also formed to overlap the edge of the protective layer 50 surrounding the region 52. Consequently, there is no gap between the anisotropic conductive

material 54 and the protective layer 50, and the wiring pattern 10 is not exposed, so that migration can be prevented.

[0073]

It should be noted that in this embodiment, it is preferable that the anisotropic conductive material 54 is cured also in the region spreading beyond the semiconductor element 20. This curing step can be carried out in the same way as in the first embodiment.

[0074]

(Fourth Embodiment)

A method of manufacturing a semiconductor device in accordance with the third embodiment is shown in Figs. 5(A) and 5(B). In this embodiment, the substrate 12 of the first embodiment is used, and an anisotropic conductive material 56 (adhesive) is provided on the substrate 12. The difference between this embodiment and the first embodiment is in the thickness of the anisotropic conductive material 56. That is to say, as shown in Fig. 5(A), in this embodiment the thickness of the anisotropic conductive material 56 is greater than the thickness of the anisotropic conductive material 16 shown in Fig. 1(A). More specifically, the anisotropic conductive material 56 is thicker than the interval between the surface 24 of the semiconductor element 20 having the electrodes 22 and the wiring pattern 10 formed on the substrate 12. The anisotropic conductive material 56 is at least slightly larger than the semiconductor element 20. It should be noted that it is sufficient for either of these thickness and size conditions to be satisfied.

[0075]

As shown in Fig. 5(A), the semiconductor element 20 is then

pressed toward the substrate 12 and heat is applied by the jig 30, for example. By doing this, the anisotropic conductive material 56 surrounds a part or all of a lateral surface 28 of the semiconductor element 20, as shown in Fig. 5(B). Thereafter, solder balls are formed in the same way as in the steps shown in Figs. 1(C) and 1(D), and the semiconductor device is obtained.

[0076]

According to this embodiment, since at least part of the lateral surface 28 of the semiconductor element 20 are covered with the anisotropic conductive material 56, the semiconductor element 20 is protected from mechanical damage. Moreover, since the anisotropic conductive material 56 covers as far as a position removed from the electrodes 22, corrosion of the electrodes 22 and so on can be prevented.

[0077]

Although the above embodiment has been described principally in terms of a chip size/scale package (CSP) of face-down bonding (FDB), the present invention can be applied to any semiconductor device to which FDB is applied, such as a semiconductor device to which Chip on Film (COF) or Chip on Board (COB) is applied, or the like.

[0078]

A circuit board 1000 on which is mounted a semiconductor device 1100 fabricated by the method of the above described embodiment is shown in Fig. 6. An organic substrate such as a glass epoxy substrate or the like is generally used for the circuit board 1000. On the circuit board 1000, a wiring pattern of for example copper is formed to provide a desired circuit. Then electrical

connection is achieved by mechanical connection between the wiring pattern and the external electrodes of the semiconductor device 1100.

[0079]

It should be noted that the semiconductor device 1100 has a mounting area which can be made as small as the area for mounting a bare chip, and therefore when this circuit board 1000 is used in an electronic instrument, the electronic instrument itself can be made more compact. Moreover, a larger mounting space can be obtained within the same area, and therefore higher functionality is possible.

[0080]

Then as an example of an electronic instrument equipped with this circuit board 1000, a notebook personal computer 1200 is shown in Fig. 7.

[0081]

It should be noted that, whether active components or passive components, the present invention can be applied to various surface-mounted electronic components. These electronic components may include resistors, capacitors, coils, oscillators, filters, temperature sensors, thermistors, varistors, variable resistors and fuses.

[0082]

[Brief Description of the Drawings]

[Fig. 1]

Figs. 1(A) to 1(D) show a method of manufacturing a semiconductor device in accordance with a first embodiment of the present invention.

[Fig. 2]

Figs. 2(A) and 2(B) show a modification of the first embodiment.

[Fig. 3]

Figs. 3(A) and 3(B) show a method of manufacturing a semiconductor device in accordance with a second embodiment of the present invention.

[Fig. 4]

Figs. 4(A) and 4(B) show a method of manufacturing a semiconductor device in accordance with a third embodiment of the present invention.

[Fig. 5]

Figs. 5(A) and 5(B) show a method of manufacturing a semiconductor device in accordance with a fifth embodiment of the present invention.

[Fig. 6]

Fig. 6 shows a circuit board on which is mounted a semiconductor device in accordance with an embodiment of the present invention.

[Fig. 7]

Fig. 7 shows an electronic instrument having a circuit board on which is mounted a semiconductor device in accordance with one embodiment of the present invention.

[Explanation of Reference Numerals]

10 Wiring Pattern

12 Substrate

16 Anisotropic Conductive Material

18 Surface

20	Semiconductor Element
22	Electrodes
24	Surface
28	Side Face
30	Jig
36	Solder Balls
38	Heating Jig
40	Electronic Part

[Document Name] ABSTRACT

[Abstract]

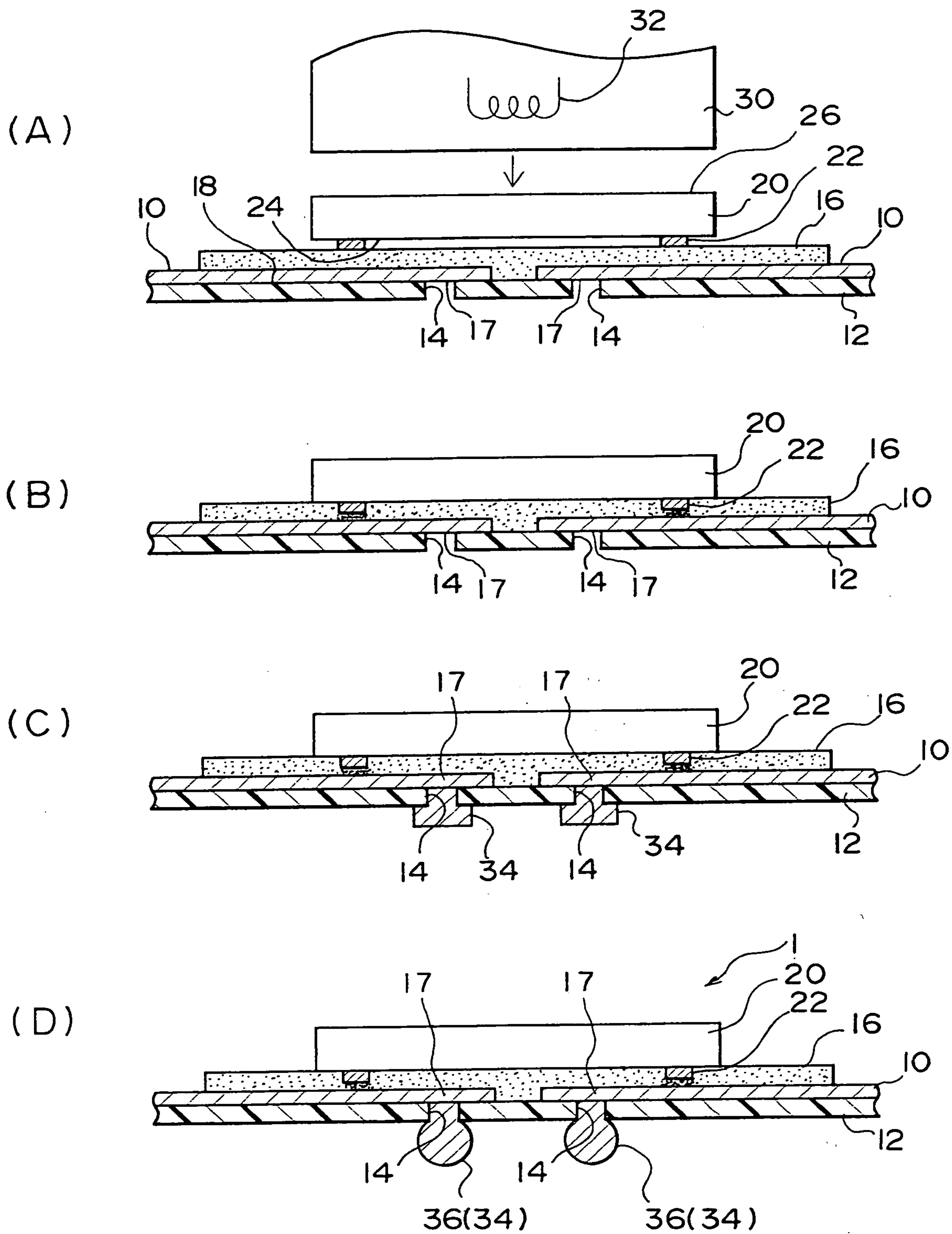
[Object] An object is to provide a method of making a semiconductor device which includes electrical connections improved in reliability and productivity.

[Means for attaining the Object]

A method of manufacturing a semiconductor device including a substrate 12, the substrate 12 having one surface 18 on which a wiring pattern 10 is formed and the other surface 24 on which electrodes 22 for a semiconductor element 20 are formed, the method comprising a first step of providing an anisotropic conductive material 16 between the surfaces 18 and 24, the anisotropic conductive material 16 including a thermosetting adhesive and conductive particles dispersed therein and being larger than the surface 24 of the semiconductor element 20, a second step of pressurizing and heating the semiconductor element 20 toward the substrate 12 to provide an electrical connection between the wiring pattern 10 and the electrodes 22, the anisotropic conductive material 16 being set in a region in which the anisotropic conductive material 16 is in contact with the semiconductor element 20, and a third step of heating a portion of the anisotropic conductive material 16 extending outwardly from the semiconductor element 20 through a reflow process in which solder balls 36 are formed.

[Selected Figure] Fig. 1

FIG.1


(A)
32
30
26
22
20
18
24
16
10
10
14
17
17
14
12
(B)
20
22
16
10
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17
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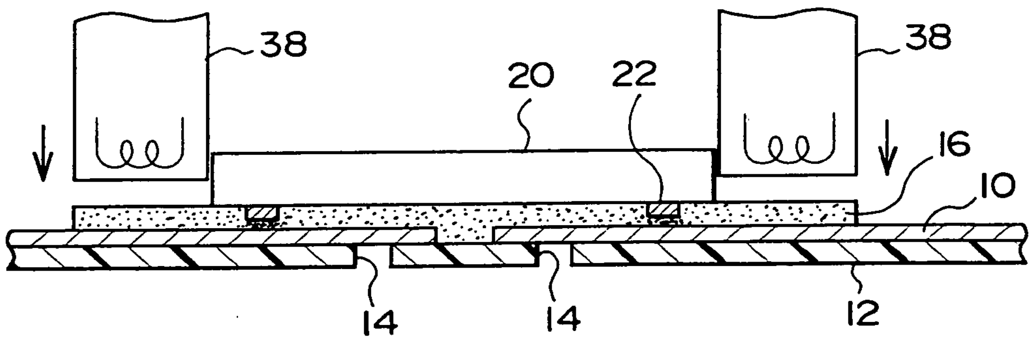
17
12
(C)
17
17
20
22
16
10
14
34
14
34
12
(D)
1
20
17
17
22
16
10
12
14
14
36(34)
36(34)

FIG.2

(A)



(B)

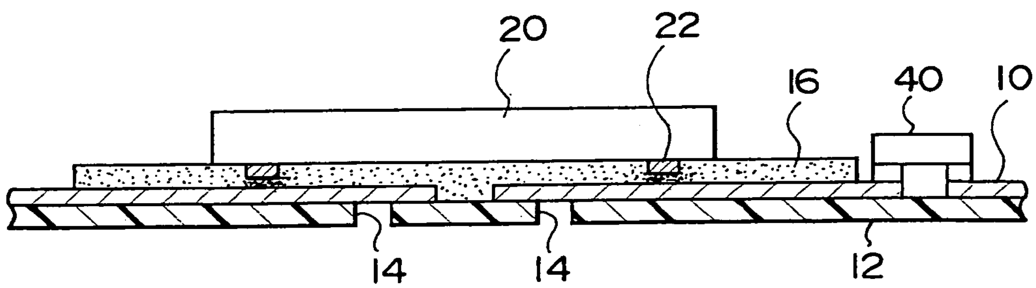


FIG.3

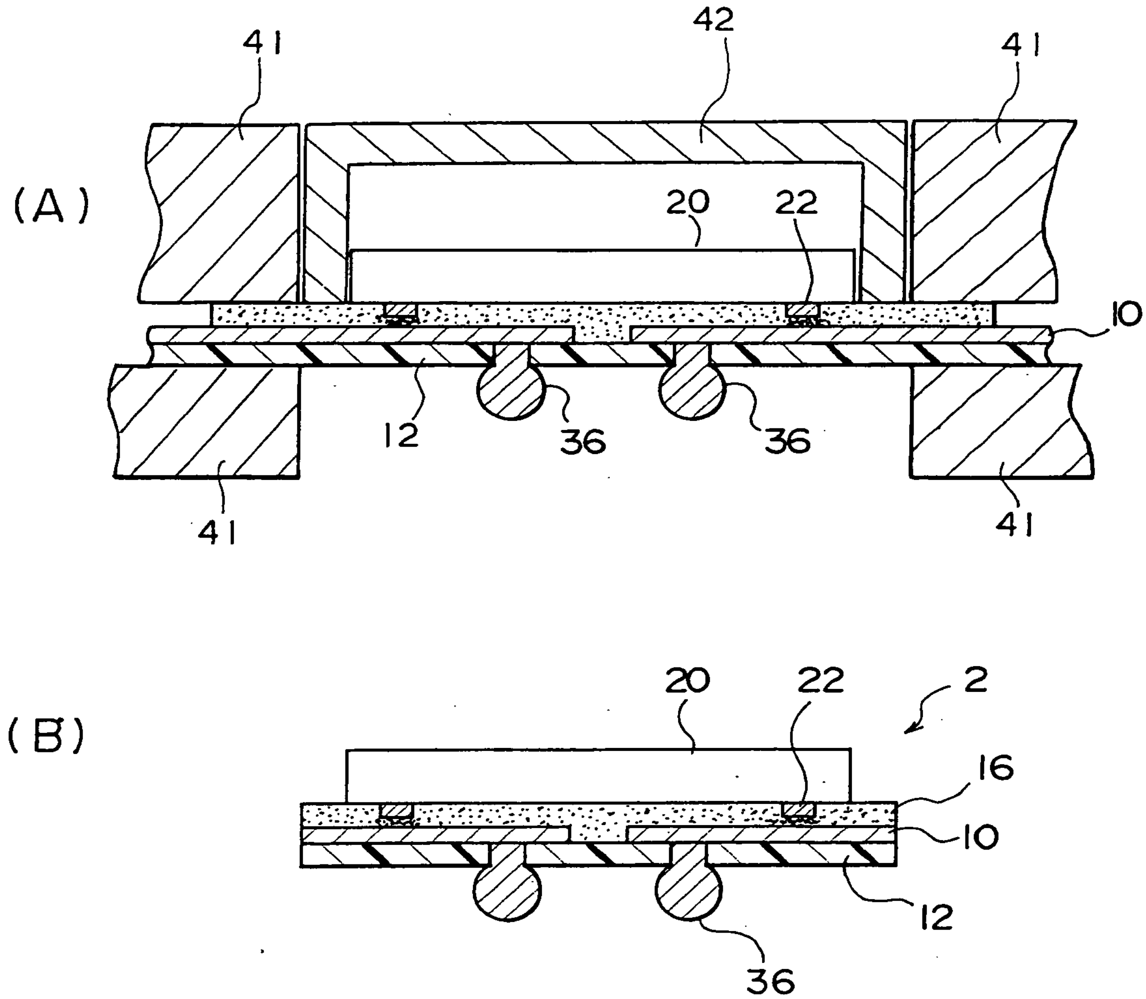


FIG.4

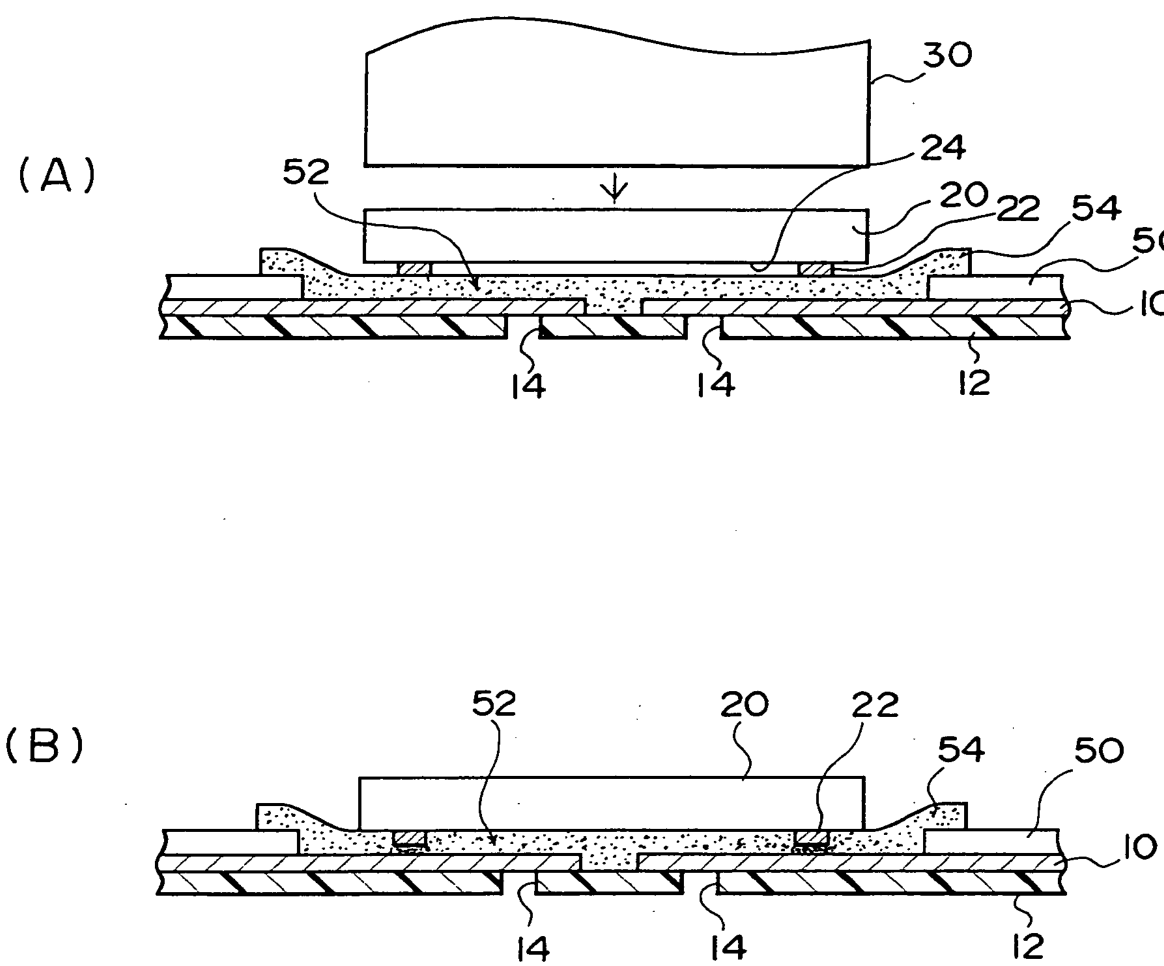


FIG.5

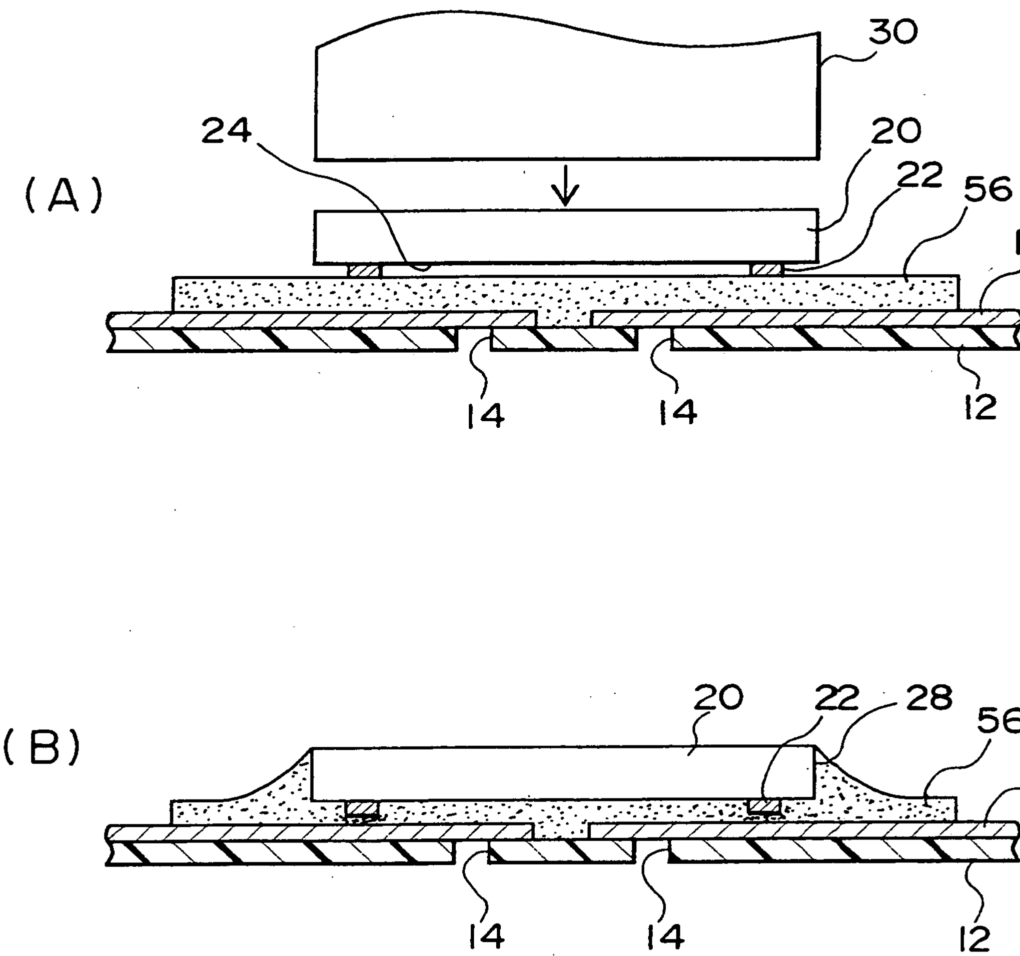


FIG.6

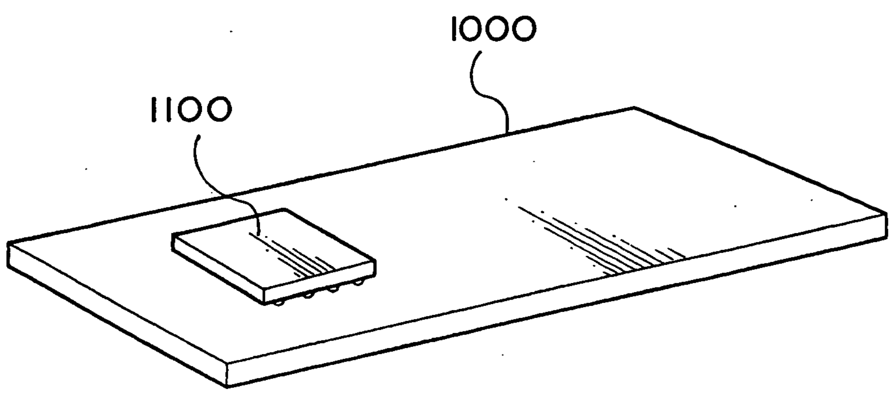


FIG.7